Simulation-Based Evaluation of Bus Lane Allocation Considering Different Bus Headways and Traffic Volumes

Master‘s Thesis of Liaqat Ali Jamal

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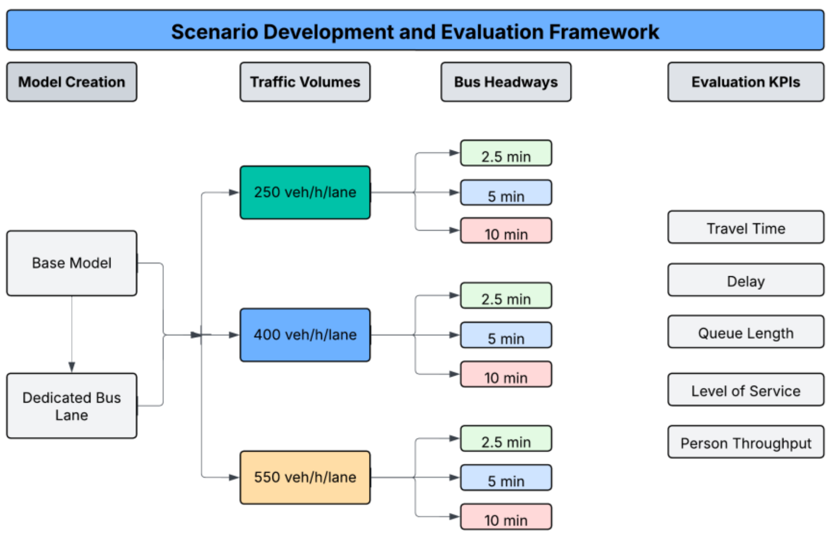

Fig.1 Scenario Development and Evaluation Framework

Motivation:

Public transport plays a crucial role in sustainable urban mobility. Traffic congestion reduces public transport reliability and decreases its attractiveness. One potential solution is a Dedicated Bus Lane (DBL) combined with bus signal priority at intersections. This master’s thesis evaluates the impact of DBL on traffic quality under different bus headways and traffic volumes.

Methodology:

This study is based on a multi-lane synthetic urban arterial network measuring 1.64 km and consisting of five signalized intersections. First, a literature review based on recent studies is conducted to understand the impact of DBL and the conditions under which it is effective. Second, PTV Vissim is used to create a base model representing mixed-traffic conditions. Third, the right-side curb lane in both major directions is converted to a DBL, and buses are prioritized at intersections. Consequently, a comparative analysis is conducted to evaluate the impact of DBL at the tested traffic volumes and bus headways using relevant KPIs.

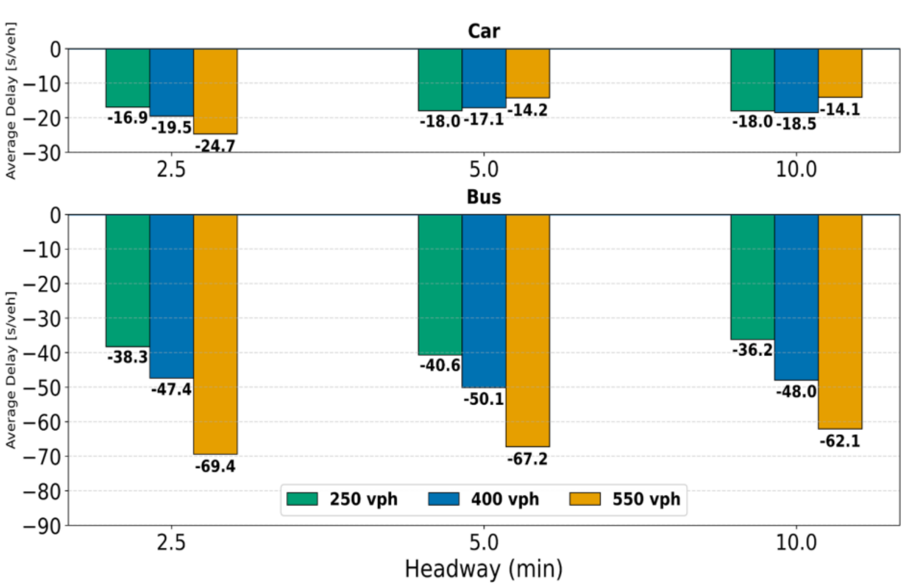

Fig. 2 Corridor Average Delay Change (sec/veh): South- North direction

Results:

DBL improves bus performance by reducing travel time and delay. For instance, the average corridor delay for buses is reduced by 36–69 s/veh, depending on traffic volume and bus headway. Higher traffic volumes and more frequent bus headways lead to greater improvement. The impact on car performance is direction-dependent. In the uncoordinated direction, car performance improves, whereas in the direction where coordination is applied only in the base model, car performance deteriorates. The improvement for cars ranges from 14 to 24 s/veh, and the deterioration ranges from 20 to 45 s/veh, depending on volume and headway. Improvement and deterioration are greater at high traffic volumes, while a frequent headway slightly reduces deterioration and increases performance improvement. Additionally, high traffic volume (550 veh/h/lane) degrades traffic quality because the queue length exceeds the storage length. Under these conditions, LOS also deteriorates and fails due to spillback and unstable operation. Low traffic volume (250 veh/h/lane) provides the best traffic quality, but its efficiency is limited. A traffic volume of 400 veh/h/lane provides a balanced impact on traffic quality and efficiency.

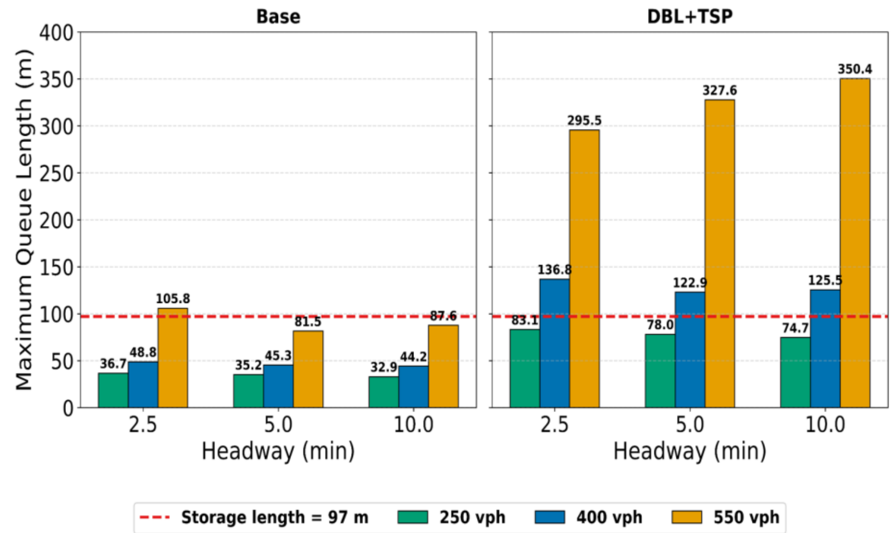

Fig. 3 Max. Queue Length at Critical Intersection: North-South Direction

Outlook:

Further studies should test a broader range of traffic volumes and bus headways using real-world data, calibrated models, and actuated signal control. In addition, passenger-kilometres, mode shift, and emissions should be considered to capture broader efficiency and sustainability impacts.

Conclusion:

Traffic volume for private transport and bus headway for public transport are key factors to consider when allocating road space between the two modes. DBL reduces road capacity and degrades traffic quality at high volumes. Frequent headway (2.5 min) improves the performance of both modes, reduces car penalties, and supports efficient bus operation, as it increases passenger throughput by public transport. Overall, DBL is most beneficial when bus demand is high and private traffic volumes remain within an acceptable range that avoids spillback and LOS failure.

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